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Diplomacy Lab Provides Term-length Group Projects Integrating Policy Analysis and Liberal Arts into the Traditional Engineering Classroom

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Professor Daniel B. Oerther, PhD, PE, BCEE, CEng, F.AAN joined the faculty of the Missouri University of Science and Technology in 2010 after ten years on the faculty of the University of Cincinnati where he served as Head of the Department of Civil and Environmental Engineering. Since 2014, he has concurrently served as a Senior Policy Advisor to the U.S. Secretary of State in the areas of environment, science, technology, and health (ESTH). Oerther earned his B.A. in biological sciences and his B.S. in environmental health engineering from Northwestern University (1995), and he earned his M.S. (1998) in environmental health engineering and his Ph.D. (2002) from the University of Illinois, Urbana-Champaign. He has completed postgraduate coursework in Microbial Ecology from the Marine Biology Laboratory, in Public Health from The Johns Hopkins University, and Public Administration from Indiana University, Bloomington. Oerther is a licensed Professional Engineer (PE, Ohio), Board Certified in Environmental Engineering (BCEE) by the American Academy of Environmental Engineers and Scientist (AAEES), and registered as a Chartered Engineer (CEng) by the U.K. Engineering Council. His scholarship, teaching, service, and professional practice focus in the fields of environmental biotechnology and sustainable development where he specializes in promoting Water, Sanitation, and Hygiene (WaSH), food and nutrition security, and poverty alleviation. Oerther's awards for teaching include the best paper award from the Environmental Engineering Division of ASEE, as well as recognition from the NSPE, the AAEES, and the Association of Environmental Engineering and Science Professors (AEESP). He participated in both the 2006 and the 2015 conferences of the National Academies Keck Futures Initiative (NAKFI) as well as the 2011 Frontiers of Engineering Education Symposium (FOEE) of the U.S. National Academies. Oerther is a four-time recipient of Fulbright, and he has been recognized with a Meritorious Honor Award by the U.S. Department of State. Due to his collaborations with nurses and healthcare professionals, Professor Oerther has been inducted as a Lifetime Honorary Member of Sigma Theta Tau, the International Honor Society of Nursing (STTI), and he has been inducted as a Lifetime Honorary Fellow of the American Academy of Nursing (F.AAN).

Diplomacy Lab Provides Term-length, Group Projects Integrating Policy Analysis and Liberal Arts into the Traditional Engineering Classroom

Abstract

Science in diplomacy, the use of trained scientist to inform and support foreign policy objectives, has been a part of U.S. foreign policy since the time of Benjamin Franklin. The Diplomacy Laboratory project, a public-private partnership, allows the Department of State to 'course source' projects to seek input from universities and to recruit talented students to consider careers in diplomacy. This paper provides a summary of a case study using a DipLab project as part of a term-length, writing assignment in courses for undergraduate and graduate environmental engineering students. An overview of DipLab and suggested best practices to integrate DipLab projects into engineering courses is also included.

Introduction

Science diplomacy refers to three types of activities, namely:[1]
1) "science in diplomacy" utilizes trained scientists to inform and support foreign policy objectives (i.e., the Environment, Science, Technology and Health (ESTH) Officer cone of the United States (U.S.) Foreign Service);[2, 3]
2) "diplomacy for science" utilizes formal relations among states to conduct scientific discovery (i.e., the Antarctic Treaty System); and[4]
3) "science for diplomacy" utilizes the personal, collaborative relationships among scientists to promote goodwill and understanding among states (i.e., the International Council for Science (ICSU)).[5]
Although "science in diplomacy" played an important role early in U.S. foreign policy – the first Ambassador to France, Benjamin Franklin, was a noted scientist and polymath, and the first science attaché was appointed to the U.S. Embassy to Germany in 1898 – the role of "science in diplomacy" became increasingly marginalized over time and by 1999 an overseas posting as a scientific attaché became viewed as a dead-end with only 15 U.S. Foreign Service Officers (FSO) in ESTH positions holding degrees in a science, technology, engineering, or math (STEM) field.[2, 3] After 9/11, and especially after the 2001 anthrax attacks, the ESTH cone has experienced a resurgence of interest, and in 2015 the National Research Council (NRC) published, Diplomacy for the 21st Century: Embedding a Culture of Science and Technology Throughout the Department of State.[6] The NRC report recognizes the lone superpower status of U.S. science and technology and outlines steps that the U.S. Department of State (DoS) should implement to better carry out its mission to, "create a more secure, democratic, and prosperous world for the benefit of the American people and the international community."[6]

The NRC report offers four, complementary activities that should be undertaken by the DoS to upgrade science and technology capabilities within the Department, including:[6]

1) utilize the Department's existing resources more effectively in responding to dramatic changes in the global landscape;
2) engage more fully with the widely dispersed science and technology capabilities within the U.S.;
3) upgrade science and technology capabilities of U.S. embassies; and
4) increase the stature and capabilities of Department officials responsible for science and technology activities.

One activity, launched by the DoS in 2013, which is aligned with the recommendations contained in the NRC report is "Diplomacy Lab" – a "public-private partnerships that enables the State Department to 'course-source' research and innovation … at colleges and universities across the U.S."[7] DipLab helps to solve real-world challenges identified by DoS in a way that [1] increases the capabilities of the U.S. Government through tapping into an underutilized reservoir of intellectual capacity while [2] simultaneously growing future capacity within the DoS by exposing students to pathways into government employment[7]. Institutions of higher education 'apply' to join the DipLab partnership, and once accepted, institutions can 'bid' on projects generated by the DoS. After a bid is selected, the course instructor at an institution serves as the primary point of contact (PoC) between the students conducting research and the officials at the DoS who are the clients for the work. DipLab projects range from narrow to regional to global geographic focus and from a focus on natural science to a focus on political science as well as intermediate sciences such as economics. Although not explicitly mentioned as part of DipLab, a subset of projects generated by the DoS require the instructor and the students to have deep knowledge of science, the scientific method, and evidence-based decision making. Many of the projects proposed by the DoS fit within the interface of pure science and applied science, and these projects often are well suited to be undertaken by interdisciplinary teams that include students of engineering.

The objective of this paper is to share details of a case study wherein a DipLab project was used to introduce undergraduate and graduate students of engineering to "science in diplomacy". The particular case-study that is highlighted in this paper – identifying which cognitive frames are most useful for reducing unnecessary antibiotic use by the public – is one of five different DipLab projects undertaken by the author since 2015. This paper includes an overview of science diplomacy, an introduction to details of DipLab, and details about the specific case study including assessment of student learning and satisfaction. Based upon the instructor's experience with additional DipLab projects, this paper extrapolates the case study to suggest best practices that may be utilized to successfully integrate DipLab projects as the subject for semester-long, group and individual work aimed at introducing engineers to "science in diplomacy".

Methods

Science Diplomacy. Within the U.S. Foreign Service, "science in diplomacy" has been an explicit career track identified by the ESTH Officer cone (skill code 6020) as established by Executive Order 12591 issued in 1987 which states, "The Secretary of State shall develop a recruitment policy that encourages scientists and engineers from other Federal agencies, academic institutions, and industry to apply for assignments in embassies of the United States."[2] Over time, the 'stand-alone' ESTH cone was merged with the Economic cone, and currently Foreign Service Officers (FSOs) may pursue one of five, separate cones, namely: Consular (C); Economic (E); Management (M); Political (P); or Public Diplomacy (PD). In contrast to FSOs who work across the broad geographic and technical areas of the DoS, most of the scientists and engineers within the DoS are employed in the Bureau of Oceans and International Environmental and Scientific Affairs (OES) as Foreign Affairs Officers (FAO) – a federal civil service position. Although subtle, the differences between the FSO and FAO career tracks can be important, and typically senior positions with the DoS – including ambassadorships – are primarily filled from the FSO career track. Thus, career diplomats interested in "science in diplomacy" (i.e., typically FAO track) may be viewed as a 'second-class-citizen' by some.[2]

To provide support to train individuals for careers in "science in diplomacy", the American Association for the advancement of Science (AAAS) created the Science and Technology Policy Fellowship (STPF) program in 1973. Details about eligibility, benefits, and application materials can be found at: www.aaas.org/program/science-technology-policy-fellowships. STPF recruits recently graduated doctoral students from science, technology, engineering, and math (STEM) fields to join the federal government for a period of up to two years. During this 'post doc', the AAAS Fellows use their training as scientists to inform and support policy objectives. Leveraging the success of the STPF program, in 2003 the DoS launched the Jefferson Science Fellows (JSF) program with administrative assistance from the National Academies of Science, Technology, and Medicine. Details about eligibility, benefits, and application materials can be found at: http://sites.nationalacademies.org/PGA/Jefferson/. JSF recruits tenured faculty from STEM + medical (STEMM) fields to join the DoS for a period of up to five years. During the first year, the faculty member is stationed in Washington, D.C. as part of a 'sabbatical'. In the remaining four years, the faculty member advises the DoS remotely. Today, there are more than 3,000 alumni of the STPF and nearly 150 alumni of the JSF. Because of their doctoral level training in STEMM as well as their network of connections within higher education and the DoS, many of these STPF and JSF program alumni are well suited and highly motivated to provide support to activities such as DipLab.

<u>Diplomacy Lab.</u> Launched by the DoS in 2013, DipLab is a public-private partnership between institutions of higher education and the DoS. Details about the ongoing, rolling application process can be found at: www.diplomacylab.org. The formal relationship between the university and the DoS is captured in a Memorandum of Understanding (MoU). Best practice includes asking the university legal council to review the MoU before seeking the required signature from an appropriate senior university administrator as needed to execute the MoU. An application to DipLab requires each university to identify a "Diplomacy Lab Coordinator" as well as an "Alternative Coordinator". These individuals serve as the primary points of contact between the DoS and the university. In some cases, a senior university administrator responsible for partnerships or international affairs serves as the Coordinator, and it other cases an experienced faculty member with broad connections across campus serves as the Coordinator. Best practice includes

identifying a team with one administrator and one faculty member. The application requires: 1) a 500-word essay detailing 'why your institution would like to participate in DipLab'; 2) selection of university core strengths from a populated menu; 3) a 500-word essay detailing 'what value your strengths would contribute to U.S. foreign policy decisions'; and 4) a 500-word essay detailing 'any prior partnerships among your institution and the DoS'. It is worth noting that each essay is limited to a maximum of 500 words – brevity and persuasion are required traits for FSOs and FAOs, and therefore brevity and persuasion are utilized as an early checkpoint for entry to DipLab.

<u>The Bid Process.</u> Universities that are members of DipLab receive an electronic list of project proposals generated by the DoS approximately 12 weeks before the start of each semester. Figure 1 includes a word cloud generated from the titles of the more than 100 separate projects generated by the DoS for bid before the Spring 2017 semester. Each university is allowed to bid on a total of eight projects proposals: four-primary and four-alternates. Each bid includes the name of the university, the name and contact information for the Diplomacy Lab Coordinator, and the name and contact information for the primary faculty member who will be leading the student team. The format for each bid allows a maximum of 500-characters highlighting who will teach, which course will be used, what are the characteristics of the students, and what will be the final product. Yes, these bids are limited to five hundred characters – that's about three Tweets! Best practice emphasizes brevity and persuasion.

Figure 1. Word cloud generated from the titles of project proposals generated by the DoS for the Spring 2017 semester.

Bids are due to the DoS approximately four weeks after the project proposals have been shared. Best practice includes a campus Diplomacy Lab Coordinator who sends a selective email blast of appropriate projects to targeted faculty. Thus, it is useful for Diplomacy Lab Coordinators to 'talk-up' DipLab among colleagues to stimulate interest before the project proposals are distributed. The selection of bids takes approximately four weeks. Therefore, an instructor has approximately four weeks of lead-time between confirmation of a successful bid and the start of the semester. While the rapid turn-around can be frustrating to the those accustomed to the typical 'slow and steady' pace of an academic year calendar, the nature of the project proposals require 'rapid turn-around' and the overall pace of the DipLab process matches the 'hectic' pace typical of the DoS.

Results – Case Study

In the Summer of 2015, the DipLab project proposals included a project entitled, "Promoting Social Sciences: a Tool to Combat Antimicrobial Resistance." Figure 2 includes the project proposal provided by the DoS. Briefly, the proposal requests that a student team explore the use of social science as a means of understanding how to combat antimicrobial resistance. Figure 3 includes the successful bid submitted by the author to win this DipLab project.

Approximately one week before the start of the Autumn 2015 semester, the instructor met via telephone conference call with three members of the DoS for a period of approximately one-hour. This call afforded an opportunity for the representatives from the DoS to clarify their proposal; for the instructor to offer a strategy for the semester; and for the representatives from the DoS to comment on the strategy. The instructor used this DipLab project as part of a term-long writing assignment for a graduate-level course in environmental microbiology with a total student enrollment of five (i.e., 6601: Biological Principles of Environmental Engineering Systems). Two of the graduate students participated in the course via distance learning, and three of the students participated via face to face. The DipLab project was incorporated as an optional assignment that students could complete to earn credit towards a grade of 'B' or 'A' during the course.

Background on DipLab and details of the briefing between the instructor and the three representatives from the DoS were shared with the students during lecture in the second week of the class. The representatives from the DoS and the students met via teleconference during the third week of the class. During the briefing during the third week of class, the representatives from the DoS shared their expectations for the project, and the students sought clarification via questions and answers. The instructor facilitated the dialogue, and recorded the details of the teleconference. Afterwards, for two weeks, each student worked independently to read the materials recommended by the DoS and to identify at least two additional reference materials, each, that reviewed linkages among social sciences and antimicrobial resistance. To share his or her finding, each student used a 5-slide PowerPoint presentation to explain what he or she had learned. Through an instructor-facilitated discussion, the students agreed to an overall outline of five critical areas for additional research, namely: 1) scientific background of antibiotic resistance; 2) branding of antibiotic resistance; 3) measuring effectiveness of existing antibiotic resistance awareness campaign; 4) alternative exemplar health campaigns; 5) alternative science/healthcare. Through written communication, the representatives from the DoS shared their input on the PowerPoint presentations and the overall outline. Using the input from the DoS, each student selected one portion of the outline in which to focus. Then, for two weeks, each student worked independently to identify at least five

Figure 2. Project proposal from DoS entitled, "Promoting Social Sciences: a Tool to Combat Antimicrobial Resistance".

Antibiotics are foundational to modern medicine and agricultural productivity. Improper use of antibiotics including incomplete treatment regimens contribute to rapid emergence and spread of bacteria strains resistant to existing antibiotics. Several recent international assessments have identified antibiotic resistance as a significant global threat to health and development and have noted that we are on course to quickly enter a post-antibiotic era – an end to modern medicine. In recognition of this threat, the May 2015 World Health Assembly is expected to adopt a Global Action Plan on antimicrobial resistance (AMR).

The conservation of current antibiotics is particularly important for combatting AMR. The development of new therapeutics is critical, but ultimately a temporary fix if the global community does not practice measures to conserve antibiotics. Antibiotic stewardship is challenging because it hinges on a variety of social and behavioral phenomena. Social science, while underused in AMR efforts to date, can help to address several critical questions.

Among them:

- Which cognitive frames for reducing unnecessary antibiotic use are most appealing to the general public, or to specific target populations? Are there differences in effective frames across or within countries or regions?
- What is the effect of human movement – for example, labor migration or displacement associated with natural disasters – on adherence to long-course drug regimens? What, if any, mechanisms have been successful in maintaining adherence during times of adversity?
- Which stakeholders (governments, civil society, etc.) have strong data that could indicate best practices, and which do not?

Format of Final Product: The team would spend one (or if desired, two) semester(s) developing a set of critical areas for further investigation, culminating in an article suitable for a peer-reviewed journal.

additional references, each, to clarify their portion of the outline. To share his or her findings, each student used a 5-slide PowerPoint presentation to explain what he or she had learned. The DoS participated via teleconference in the instructor-facilitated discussion. Then, for four weeks, each student worked independently to write a five-page, singled-spaced, draft document with a minimum of fifteen references, each, that clarified his or her portion of the outline. Through written communication, the representatives from the DoS shared their input on the draft papers. Using the input from the DoS, each student modified his or her final paper, and collectively the students created a single PowerPoint presentation that was delivered to a briefing with a larger team of DoS representatives at the end of the semester. The collection of five, five-page, single-spaced final papers was also delivered to the representatives of the DoS, and the instructor assigned grades for each paper. By providing multiple touch-points between the representatives of the DoS and the students, the authenticity of the project was promoted and the suitability of the final product was encouraged. Separate grading by the instructor ensured that students' educational objectives were met as well.

Figure 3. Bid proposal for the Missouri University of Science and Technology submitted by Professor Daniel B. Oerther (495 characters with spaces).

> Prof Dan Oerther (2014/5 Jefferson Science Fellow in S/GFS) will oversee through a grad-level environmental microbiology course. Assoc Prof of Microbiology, Dave Westenberg will participate using pathogenic microbiology undergrads as part of public service learning. Both faculty have reviewed the U.S. National Action Plan for Combating Antibiotic-Resistant Bacteria (2015), both faculty have published with the government, and project implementation will include social science collaborators.

The written products and the briefing materials generated during the Autumn 2015 semester served as the starting point for a follow-up course during the Spring 2016 semester. Approximately one week before the start of the Spring 2016 semester, the instructor met via telephone conference call with three members of the DoS for a period of approximately one-hour. This call afforded an opportunity for the representatives from the DoS to share their candid experience during the Autumn 2015 semester; for the instructor to offer a strategy for the Spring 2016 semester; and for the representatives from the DoS to comment on the strategy. The instructor used this DipLab project as part of a term-long writing assignment for a junior/senior-level course in environmental health engineering with a total student enrollment of twenty-two (5650: Public Health Engineering). Two of the students participated in the course via distance learning, and the remaining students participated via face to face. The DipLab project was incorporated as an optional assignment that students could complete to earn credit towards a grade of 'B' or 'A' during the course. Background on DipLab and details of the briefing with the DoS were shared with the students during lecture in the second week of the class. The representatives from the DoS and the students met via teleconference during the third week of the class. During the briefing during the third week of class, the representatives from the DoS shared their experience with the Autumn 2015 semester as well as their expectations for the Spring 2016 semester, and the students sought clarification via questions and answers. The instructor facilitated the dialogue, and recorded the details of the teleconference. Thereafter, for two weeks, each student worked independently to read all five of the papers written during the Autumn 2015 semester. Through an instructor-facilitated discussion, the students agreed to split into groups focused on each of the five papers from the Autumn 2015 semester. Each student group subsequently spent two weeks de-constructing their chosen paper and re-forming an outline based upon what had been included in the papers from the Autumn 2015 semester. Through written communication, the representatives from the DoS shared their input on the outline prepared by each team of students. Using the input from the DoS, each student worked independently for two weeks to identify at least five new references to expand his or her respective outline. The teams of students then compared their independent work, and selected a total of the five best new references to incorporate into a presentation. To share their findings, each team of students used a 5-slide PowerPoint presentation to explain what they learned. The DoS participated via teleconference in the instructor-facilitated discussion. Then, for four weeks, each team of students worked together to re-write a five-page, singled-spaced, draft document that included the original plus five new references, each. Through written communication, the representatives from the DoS shared their input on the draft papers. Using the input from the DoS, each team of students modified their final paper, and collectively the students created a single overall paper as well as a PowerPoint presentation that was delivered to a briefing with a larger team of DoS representatives at the end of the semester. The final paper was also delivered to the representatives of the DoS, and the instructor assigned grades for each student based upon the quality of the team paper and peer-assessments of team participation in the project. The de-construction and subsequent re-construction as well as assembly into a final, single manuscript with multiple touch-points between the representatives of the DoS and the students emphasized the subject matter, teamwork, and effective writing.

The written products and the briefing materials generated during the Spring 2016 semester served as the starting point for a follow-up course during the Autumn 2016 semester. Approximately one week before the start of the Autumn 2016 semester, the instructor met via telephone conference call with three members of the DoS for a period of approximately one-hour. This call afforded an opportunity for the representatives from the DoS to share their candid experience during the Spring 2016 semester; for the instructor to offer a strategy for the Autumn 2016 semester; and for the representatives from the DoS to comment on the strategy. The instructor used this DipLab project as part of a term-long writing assignment for a graduate-level course in environmental microbiology with a total student enrollment of four (6601: Biological Principles of Environmental Engineering Systems). Two of the graduate students participated in the course via distance learning, and two of the graduate students participated via face to face. The DipLab project was incorporated as an optional assignment that students could complete to earn credit towards a grade of 'B' or 'A' during the course. Background on DipLab and details of the briefing with the DoS were shared with the students during lecture in the second week of the class. The representatives from the DoS and the students met via teleconference during the third week of the class. During this briefing in the third week of class, the representatives from the DoS shared their experience with the Autumn 2015 and Spring 2016 semesters as well as their expectations for the Autumn 2016 semester, and the students sought clarification via questions and answers. The instructor facilitated the dialogue, and recorded the details of the teleconference. Subsequently, for two weeks, each student worked independently to read all five of the papers written during the Autumn 2015 semester as well as the fully compiled paper written during the Spring 2016 semester. Through an instructor-facilitated discussion, the students agreed that the approach for Autumn 2016 would be for each student to work separately to write a five-page, single-spaced paper that succinctly and persuasively encapsulated all of the arguments included in the papers from Autumn 2015 and Spring 2016 (i.e., each student would start with approximately 60 pages of single-spaced text, and reduce this to a five-page draft). Each student subsequently spent four weeks re-writing his or her individual, five-page draft. Through written communication, the representatives from the DoS shared their input on the draft papers prepared by each student. Using the input from the DoS, each student worked independently for two weeks to complete his or her individual, five-page paper. To share his or her final paper, each student used a 10-slide PowerPoint presentation. The DoS participated via teleconference in the instructor-facilitated discussion. Then, for four weeks, the students worked together to re-write a single, five-page, singled-spaced, draft document that represented the best work from all three semesters. Through written communication, the representatives from the DoS shared their input on the draft paper. Using the input from the DoS, the students worked together to finalize a single, five-page, single-spaced document, and collectively the students created a single PowerPoint presentation that was delivered to a briefing with a larger team of DoS representatives at the end of the semester. The single, five-page, single-spaced final paper was also delivered to the representatives of the DoS, and the instructor assigned grades for each student based upon both their performance on their individual papers as well as peer-assessments of team participation in preparing the single, final paper.

To assess student performance, final grades for each semester were determined according to the published syllabus. For the Autumn 2015 offering of 6601: Biological Principles of Environmental Engineering Systems, each of the five graduate students enrolled in the course earned a grade of ‘A’. For the Spring 2016 offering of 5650: Public Health Engineering, a total of five students earned a grade of ‘C’, a total of eight students earned a grade of ‘B’, and a total of nine students earned a grade of ‘A’. For the Autumn 2016 offering of 6601: Biological Principles of Environmental Engineering Systems, each of the four graduate students enrolled in the course earned a grade of ‘A. To assess student satisfaction with the course, anonymous surveys were made available to each student via an online tool as administered by the campus-wide Committee on Effective Teaching (CET). The results of student satisfaction for the courses examined in this case study are provided in Table 1. Overall, the graduate students were more satisfied with the course as compared to the undergraduate students. To better understand any concerns of the students, anonymous, open-ended free-response questions are also included in the electronic survey. Table 2 provides representative results to the question of what are strengths, weakness, or opportunities for improvement for the instructor or for the course.

Table 1. Results of anonymous survey questions electronically available to all students via an online tool at the end of each semester. Students scored their agreement (5) or disagree (1) on a Likert-scale to each of a series of statements.

Statement	**a**	**b**	**c**
The course was valuable (independent of the instructor's effectiveness)	5	3.7	5
The instructor was concerned that I learned the material	5	3.7	4.5
The instructor stimulated and motivated me	5	3.3	4.5
The instructor was an effective teacher	5	3	5
I would recommend this instructor to other students	4.3	3.7	4.5

a 6601: Biological Principles of Environmental Engineering Systems, Autumn 2015
b 5650: Public Health Engineering, Spring 2016
c 6601: Biological Principles of Environmental Engineering Systems, Autumn 2016

Clearly, the DipLab project was well liked by some students, and viewed very negatively by other students. It was surprising that the DipLab project would produce such strong responses from students as the author has not observed this type of strong response in any other class. It is interesting to note that Missouri is a 'purple' state – meaning that there is both a strong Democratic and a strong Republican presence throughout the state. It would be interesting in future assessments to consider if political party affiliation as compared to political party control of various functions in the federal government have a strong correlation to the satisfaction of students in a course that includes a DipLab project.

Table 2. Representative student comments on an anonymous, end-of-term survey to the open-ended question, "what are strengths/weakness/opportunities for improvement for the instructor," or "for the course?"

I loved the diplomacy lab project! It made learning biology much more real, and I was excited to read about antibiotic resistance in the newspaper while we were still working on the project in class! Super timely!
Didn't take much effort to still earn a B or an A. I don't want you to give us more work, but it seemed too easy to earn a high grade (compared to other courses).
Complete abuse of power! Its great that you do work for the State Department and partnered with them for the diplomacy, but educationally I think it is unacceptable for force student participation in the diplomacy lab as the only possible way to get an A in the class.
Spend more time on going over the course material and less time on the optional project discussion.
I loved the open ended nature of discussion, but please use 'yes and' rather than 'but' when correcting statements in class. We're just students and we should get more credit when we try to answer questions!

Discussion Beyond the Case Study

The case study presented in this paper is one example of the author's involvement with a DipLab project. Table 3 includes a complete listing of all five DipLab projects with which the author has been involved. Two the projects – antibiotics and societal limits to data sharing – we used as term-length projects as part of lecture-discussion courses; whereas three of the projects – water-smart city, cross-cultural communication, and climate smart agriculture – were undertaken as part of independent, undergraduate research. In each of these courses, a similar pattern of engagement has emerged. Approximately one week before the beginning of the semester, the instructor holds a telephone conference call with representatives from the DoS. Early in the semester, the instructor explains DipLab to the students. Subsequently, the students and the representatives from the DoS hold a teleconference briefing, and the instructor facilitates an agreement to a plan of work and a description of the final product. The students then complete a portion of the work, and share their findings with both the instructor and the representations from the DoS in either a written or an oral format. Using the feedback from the DoS, the students complete a second round of work and offer a draft of the final product for additional feedback. The students then incorporate the second round of feedback into the delivery of the final product, which always includes both a written document as well as an oral briefing to a larger team of representatives from the DoS. The instructor assigns any grade associated with the final product, and the representatives from the DoS provide their final comments to the students. Subsequent to the end of the class, the instructor does a final briefing with the representatives from the DoS to collect any lessons learned and to plan any additional follow-up activities.

DipLab was established in 2013 with a cohort of five universities as part of the pilot phase. It was expanded to 20 university partners in 2015 and includes 28 universities currently. Among these 28 institutions, only three qualify as technological research universities, including Georgia Institute of Technology, Missouri University of Science and Technology, and Stevens Institute of Technology – defined as: a) at least 25% of the student body majors in engineering; b) at least 50% of the student body majors in STEM; c) terminal degrees include PhD; d) research intensive; and e) liberal arts, humanities, and social sciences complement and lend context to the technological strengths of the university. Since the pilot phase in 2013, the number of project descriptions has increased steadily, and for Spring 2017 approximately 100 potential projects were available for bid by the 28 partner universities. The word cloud generated from the titles of project proposals released by the DoS for the Spring 2017 semester (Figure 1) is interesting as the word science appears only twice in the more than 100 different titles. In contrast, a number of words – U.S., diplomacy, security, mapping, foreign, civil, and human – all appear in more than 6 titles, each. Thus, while engineering has been identified as an important aspect of science diplomacy, there is a lack of evidence to show that the DoS is looking to use DipLab to access engineering expertise. Similarly, the DipLab topics undertaken by the author (i.e., Table 3), are not immediately linked to 'engineering', but rather the approach that engineers use for problem solving – recognizing a need; defining the problem, objectives, and constraints; collecting and

Table 3. Details of author's experience integrating DipLab projects as term-length projects at the Missouri University of Science and Technology.

DipLab topic	Course detail(s)	Student detail(s)	Final product(s)
which cognitive frames for reducing unnecessary antibiotic use are most appealing to the general public?	6601[a] microbiology, Autumn 2015 5650[b] health, Spring 2016 6601[a] microbiology, Autumn 2016	5 graduate students: 3 engineers, 1 scientist, 1 nurse 23 undergraduate students 4 graduate students: 3 engineers, 1 scientist	5 individual papers, 5 pages each 1 collective paper, 20 pages; and 3 individual papers, 5 pages each 2 collective papers, 20 pages and 5 pages
how are citizens able to engage politicians in promoting a water-smart city?	4099[c] research, Autumn 2015	2 undergraduate students: 1 for-credit; 1 not-for-credit	1 poster
what are best practices for cross-cultural communication about the benefits of agricultural biotechnology?	4099[c] research, Autumn 2016 4099[c] research, Spring 2017	3 undergraduate students: 3 not-for-credit 1 undergraduate student: 1 for-credit	1 slide deck; and 1 collective paper, 5 pages 1 individual paper, 10 pages
what is the best approach to promote climate smart agricultural practices in developing countries?	4099[c] research, Spring 2017	1 undergraduate student: 1 for-credit	1 individual paper, 10 pages
what are societal limits to data sharing that could potentially be used to measure nuclear non-proliferation?	5605[d] modeling, Autumn 2016	8 undergraduate students	8 slide decks; and 1 collective paper, 10 pages

a 6601: "Biological Principles of Environmental Engineering Systems"
b 5650: "Public Health Engineering"
c 4099: "Undergraduate Research"
d 5605: "Environmental Systems Modeling"

using data; generating alternative solutions; developing criteria; evaluating alternative against criteria; and communicating the best solution – has proven highly effective for creating a final product acceptable to the DoS. In fact, although some of the open-ended feedback from the students was highly negative of the DipLab experience (i.e., Table 2), the feedback the instructor received from every briefing with the representatives from the DoS has been uniformly positive, uniformly complimentary, and included much gratitude for the effort and admiration for the quality of the deliverables.

The role for engineers in "science for diplomacy" has been discussed recently by Andrew Reynolds, formerly the Deputy Science Advisor to the Secretary of State, in his presentation to the 2012 Engineering Deans Institute.[8] Reynolds noted that engineering diplomacy could be viewed as a form of 'smart' power to compliment the well-known forms of 'hard' power (i.e., military) and 'soft' power (i.e., culture and values). He encouraged engineering deans to empower their faculty to explore participating in the JSF program, and he encouraged engineering deans to promote the AAAS STPF program among graduating doctoral students. In 2012, Najmedin Meshkati offered additional commentary on the value of engineering diplomacy.[9] Meshkati noted that the term 'science diplomacy' often is used to refer to the establishment of personal and professional relationships among scientists who are actively studying a particular phenomenon (i.e., science for diplomacy). Similarly, the term 'engineering diplomacy' may be used to refer to the establishment of personal and professional relationships among engineers who are actively building the infrastructure that makes possible modern human civilization (i.e., engineering for diplomacy). Oerther elaborated on the value of integrating engineering and diplomacy in his reflection on the 70th anniversary of the Fulbright program.[10] Because engineers are required to employ a systems orientation and the recognition of design constraints, engineering for diplomacy can focus upon the realities needed to address the fourteen grand challenges facing global humanity – from advanced personal learning to engineering the tools of scientific discovery.[11]

By establishing partnerships between the DoS and U.S. colleges and universities, DipLab provides students with a mechanism to participate in the work of the Department while allowing policymakers to tap into an underutilized reservoir of intellectual capacity. The program gives the DoS the opportunity to receive the benefits of practical research related to their issues, while also contributing to the public diplomacy goals of the DoS. Conversely, students participating in DipLab under the guidance of faculty experts have an opportunity to explore real world challenges. As described in this case study, the use of term-length DipLab projects provides an opportunity for engineering students to engage in authentic learning – wherein their skills as engineers are put to use working on challenges outside of their immediate area of competence and training with a real, practical benefit to the U.S.

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